



Forest Health Protection

Pacific Southwest Region

Northeastern California Shared Service Area

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To: District Ranger, Big Valley Ranger District, Modoc National Forest

Subject: Borate stump treatment for Kresge and Caldera Project Areas
(FHP Report NE17-2)

Kresge Project: On July 21, 2016, Bill Woodruff, Forest Health Protection (FHP) Plant Pathologist, with Danny Cluck, FHP Entomologist and John Landoski, Big Valley Ranger District Culturist examined the Kresge Project area for insect and disease concerns. The project area is primarily a white fir forest with ponderosa and Jeffrey pine trees interspersed in varying densities. In some locations, past logging left individual large pine stumps in sometimes pure white fir stands; indicating that the Kresge Project area is capable of growing ponderosa and Jeffrey pine; a fact demonstrated by many acres of apparently healthy pine plantations growing in and around the project area.

Past cutting of large white fir trees in the Kresge Project area probably left white fir stumps infected with *Heterobasidion occidentale*; adding to the naturally occurring levels of heterobasidion root disease present prior to logging. Infected logging wounds on residual white fir trees would also have added to the disease present. *Heterobasidion* root disease is present in white fir in varying amounts throughout the project area. This fact has been documented by FHP in evaluations completed for past vegetation management projects conducted in and near the Kresge Project area. Signs of heterobasidion root disease were found in white fir roots and stumps in the Kresge Project area (Figure 1). Therefore treating stumps with borates to prevent heterobasidion root disease in the project area may or may not be advised depending on the current health of the stands being treated. Borate applied to freshly cut conifer stump surfaces only prevents *Heterobasidion* spores from infecting those stumps. Borate stump treatment does not kill *Heterobasidion* sp. that is already growing in roots of cut conifers. Therefore, treating white fir stumps in project units where most of the white fir roots are thought to be infected will be ineffective. Treating fir stumps in units with little or no heterobasidion root disease could be beneficial in protecting healthy white fir trees in those units.



Figure 1. (Top) Delaminated root wood from an uprooted white fir tree which is a typical decay caused by *H. occidentale*. Note: the decay is smooth on one side of the growth ring and rough on the other.. **(Bottom)** Older dead *H. occidentale* conk

One way to estimate the amount of heterobasidion root disease in a project unit is to visually assess the overall health of tree crowns. White fir growing on good a site should have full and green crowns with good annual height growth. Leader growth should average more than a foot a year. A white fir mortality center (Figure 2) is a symptom of heterobasidion root disease because even though the disease normally doesn't kill white fir trees, it will weaken them; making them susceptible to successful fir engraver attack. Also, fir engraver beetles usually kill individual trees,



Figure 2. White fir trees weakened by Heterobasidion root disease are usually the first to be overcome by fir engraver beetles.



Figure 3. Large numbers of downed white fir trees indicates that Heterobasidion root disease may be present.



Figure 4. Delaminated white fir wood.

not groups of trees. Large numbers of downed white fir (Figure 3) can also be a symptom indicating that root disease is present, especially if delaminated wood (Figures 1&4) can be found in exposed roots and butts.

In determining whether to treat white fir stumps with borates to prevent heterobasidion root disease the treatment units should be surveyed for symptoms of the root disease. If root disease symptoms are rare or absent in a unit, treat all white fir stumps greater than 14" in diameter. If symptoms suggest that over half of the area has infected roots, then stump treatment will probably be ineffective for white fir in that unit. In determining the amount of root disease in an area, it is important to know that roots with little heterobasidion infection will probably show no symptoms; but will display symptoms in the future when the fungus colonizes a sufficient volume of root wood. Therefore the symptoms being used to estimate the amount of root disease in a unit will always underestimate the amount of disease present.

No root disease was found in ponderosa and Jeffrey pine in the Kresge Project. None-the-less, the Modoc NF has a history of heterobasidion root disease in ponderosa pine and treating pine stumps has been a common practice. Therefore, for the Kresge Project, it is recommended to treat all pine stumps larger than 14" diameter to prevent *H. irregulare* from colonizing the roots of cut ponderosa pine trees. Once in the roots, this pathogen can survive for 30 or more years and spread through roots and kill adjacent pine trees which have roots growing in contact with the diseased roots; including pine regeneration that establishes near infected stumps.

Caldera Project: Much of this project is in or near recreation sites. It has been the policy of the Forest Service in California to borate treat all conifer stumps 3" diameter and larger in recreation and administrative sites to prevent heterobasidion root disease from becoming established in places frequently used by people. Outside the rec sites in the Caldera Project, stumps 14" diameter and larger need to be treated in areas determined to need protection from heterobasidion root disease. Primarily lodgepole pine will be harvested where reducing mountain pine beetle (MPB) susceptibility is the management emphasis. Red fir and mountain hemlock are present but are not susceptible to MPB attack, however these tree species could be harvested within the fuel breaks and during the creation of landings, skid trails and temporary roads. Borate stump treatment is recommended for healthy red fir and mountain hemlock trees. As in the Kresge Project, fir stumps in true fir stands where most fir roots are already infected with *Heterobasidion sp.* need not be treated. All ponderosa and Jeffrey pine stumps 14" and larger should be treated. Lodgepole pine stumps do not appear to be seriously impacted by heterobasidion root disease but since lodgepole pine is a host, it is recommended to treat those stumps as well.

Consult Forest Service Handbook R5 Supplement 3409.11-2010-1 and the attached 'Heterobasidion root disease biology' for more information on heterobasidion root disease and management considerations.

If you have any questions regarding this report and/or need additional information please contact Bill Woodruff at 530-252-6680.

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Heterobasidion root disease biology

Heterobasidion spp. is a fungus that infects primarily conifers on all National Forests in California; with incidence particularly high in true fir stands in northern California, in eastside pine type forests, and in southern California recreation areas. While Heterobasidion root disease is a natural part of most forest ecosystems in the West contributing to structural and species diversity, incidence and impacts in many California forests have increased in recent decades due to management practices. Heterobasidion root disease is found on all western conifer species but is of most concern on true firs, hemlocks (western and mountain) and pines (ponderosa and Jeffrey). Incense cedar, coast redwood and sequoia are sometimes infected in California. Western juniper is infected throughout its range.

Heterobasidion is an important stress-causing agent and its negative impacts on root systems result in predisposing conifers to bark beetle attack. In true firs severely affected by Heterobasidion root disease, the water absorbing and conducting parts of the root system are progressively diminished and eventually water lost to transpiration cannot be replaced at a fast enough rate. This leads to moisture stress, especially towards the top of the tree, and predisposes the tree to fir engraver attack. In pines affected by this disease, root systems are similarly impacted and the trees become more susceptible to pine bark beetles.

Heterobasidion spp. was considered a single species (*Fomes annosus*) until thirty years ago. Heterobasidion root disease in western North America is now reported to be caused by two species: *Heterobasidion occidentale* (also called “S-type” [spruce]) and *H. irregulare* (also called “P-type” [pine]). These two species of *Heterobasidion* have major differences in host specificity. *H. irregulare* (P-type) infects ponderosa pine, Jeffrey pine, sugar pine, Coulter pine, lodgepole pine, incense cedar, western juniper, pinyon, and manzanita. *H. occidentale* (S-type) infects true fir, mountain hemlock, Douglas-fir, giant sequoia, coast redwood, western hemlock and spruce. Both Heterobasidion species can infect stumps of non-hosts as saprophytes; however the fungus very rarely spreads from a non-host to a host species, either between trees or stumps and trees.

The typical pattern of Heterobasidion root disease in pine stands is scattered dead pine trees centered around large old pine stumps. There are often old dead snags and downed trees with rotten roots near the stumps and more recent mortality and symptomatic live trees further away. Mortality usually does not start to occur around stumps until 15 or more years after they are created.

In true fir stands, Heterobasidion root disease often does not produce obvious evidence of infestation. Mortality is infrequent to rare in standing trees, but large true fir trees with extensive root and butt rot may be broken or windthrown; and have declining crowns and dead branches. Other infected true fir trees of all sizes may have green crowns with poor height growth and dead tops from successful fir engraver attacks. Sometimes the presence of *H. occidentale* is only discovered when a stand is thinned or harvested and decay and stain is observed in the stumps.

Colonization of freshly created stump or wound surfaces by germinating spores is a critical stage in the disease cycle. Conks (fruiting bodies) produce spores which disseminate throughout the year, but depend on favorable environmental conditions for successful germination and establishment. Temperature is important for successful infection of stump surfaces. Spores are inactivated after 60 minutes above 113° F (45° C). Actively growing mycelia can be killed at temperatures above 95° F (35° C). However research suggests that microbial activity at the stump surface plays a synergistic or interactive role in stump infection. Therefore both 95° F temperature and microbes are thought to be needed to stop *Heterobasidion* spp. at the stump surface.

Stumps are susceptible to infection immediately after cutting. Ponderosa and Jeffrey pine (PP/JP) stumps remain susceptible to infection for 2 to 4 weeks. The decrease in susceptibility with time probably results from colonization of the stumps by other microorganisms that compete with and replace *Heterobasidion*. Vertical penetration of fungal hyphae into stumps depends on temperature and extent of tree injury from other sources. In PP stumps, the rate of vertical penetration averages 3 inches/month from October through May and 5 to 6 inches/month from June to October.

Preventive actions may include implementing silvicultural treatments to lessen stand susceptibility to *Heterobasidion* root disease such as thinning, species management, and minimizing logging damage and other injuries. However, many silvicultural treatments leave stumps behind; therefore prevention of *Heterobasidion* root disease usually includes treatment of freshly-cut conifer stumps with a fungicide. The probability of infection of freshly cut conifer stumps can be reduced by applying a registered borate fungicide soon after the tree is felled. Studies indicate that stump treatment with borates has at least a 90% efficacy in preventing infection under conditions that would otherwise have led to stump colonization by *Heterobasidion* spp. Borates are toxic to recently germinated spores of these fungi but they do not have an effect on existing infections. Therefore true fir stands with most of the roots chronically infected may not benefit from borate stump treatment. Borate treated PP/JP stumps 14" and larger will usually be effective in limiting *Heterobasidion* root disease in stands where existing host conifers have root contact with the roots of treated stumps.

When a stand is cleared, by clearcutting or wildfire salvage logging, and planted with PP/JP seedlings, *Heterobasidion*-caused seedling mortality can only occur when a root of a seedling grows into contact with an infected pine root. The years it takes a PP/JP seedling root to grow into contact with a root of an infected pine stump provides opportunity for soil microbial activity to colonize and begin decomposition of the stump root; thereby excluding *Heterobasidion*. Small roots are colonized and decomposed fastest; larger roots require many years. The smaller a PP/JP stump, the smaller its roots and the more likely the roots will be colonized by competing organisms; making them incapable of spreading *Heterobasidion* spp. The preceding discussion may explain why in four eastside pine stands surveyed on the McCloud Ranger District, Shasta-Trinity National Forest in 1988, untreated pine stumps less than 30" in diameter had less than 10% infection rates from *Heterobasidion* spp. Twenty years of informal monitoring of JP/PP planted clearcuts on private and public lands in northeastern California found minimal seedling mortality in clearcuts where stumps were not treated with borates. Usually one or two planted seedlings located next to an occasional very large infected pine stump or two in each clearcut are killed by *H. irregulare* within a decade of planting; and the disease appears to stop there; suggesting no need to treat stumps in clearcuts and fire clearings where PP/JP seedlings will be planted. When a true fir stand infested with *Heterobasidion* root disease is cleared and planted with pine seedlings, stump treatment is also unnecessary because *H. occidentale* typically does not kill pine seedlings.

References

USDA FS Forest Insect and Disease Leaflet 172 (Revised February 2000)

USDA FS General Technical Report PSW-116; Proceedings of the Symposium on Research and Management of Annosus Root Disease (*Heterobasidion annosum*) in Western North America April 18-21, 1989, Monterey, California.

USDA FS Handbook - R5 SUPPLEMENT 3409.11-2013-1; Forest Health Protection Handbook, Chapter 60 – Management of Specific Pests; Effective Date - 6/10/2013